RICOH

Small Cubic Type

VGA CCD

Monochrome PoCL Camera Link Camera

FV-L030B1

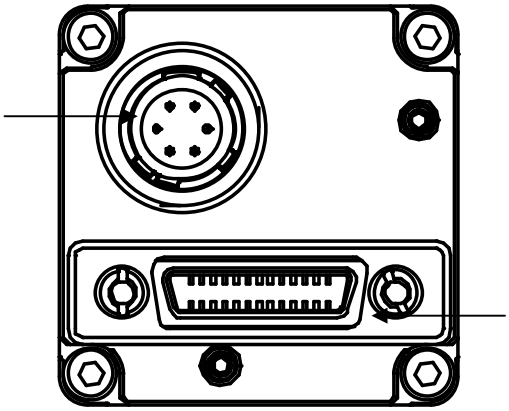
User's Guide

RICOH COMPANY, LTD.

RICOH

Tables of Contents

1 Connector Specifications



1.1 Camera Link Connector

SDR (3M) or equivalent

This product is a PoCL type.
When a frame grabber is PoCL compliant, DO NOT SUPPLY POWER FROM THE I/O CONNECTOR.
When a frame grabber is NOT PoCL compliant, supply power from the I/O connector.

Pin Assignment

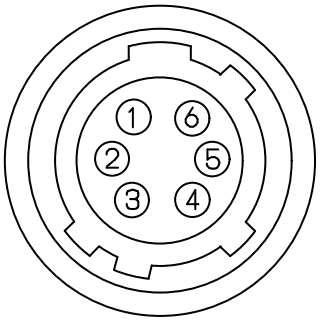
Pin No.	Signal Name	Pin No.	Signal Name
1	+12V	14	GND
2	X0-	15	X0+
3	X1-	16	X1+
4	X2-	17	X2+
5	Xclk-	18	Xclk+
6	X3-	19	X3+
7	SerTC+	20	SerTC-
8	SerTFG-	21	SerTFG+
9	CC1-(TRG)	22	CC1+(TRG)
10	CC2+	23	CC2-
11	CC3-	24	CC3+
12	CC4+	25	CC4-
13	GND	26	+12V

1.2 Power-I/O Connector

- HR10A-7R-6PB（Hirose）or equivalent
- This connector is for the power supply (12Vdc) and input /output signals.
- Use HR10A-7P-6S (Hirose) or equivalent for the cable side.

Pin Assignment

Pin No.	Signal Name	IN / OUT	Voltage		
				Low Voltage	High Voltage
1	GND	IN	0V		
2	I/O-1	IN/OUT	IN	0 to +0.5	+2.5 to +5.0V
			OUT	0V	+3.3V
3	I/O-2	IN/OUT	IN	0 to +0.5	+2.5 to +5.0V
			OUT	0V	+3.3V
4	I/O-3	IN/OUT	IN	0 to +0.5	+2.5 to +5.0V
			OUT	0V	+3.3V
5	I/O-4	IN/OUT	IN	0 to +0.5	+2.5 to +5.0V
			OUT	0V	+3.3V
6	+12Vdc	IN	+12Vdc		



- Input/output signals can be assigned through the camera setting communication (see table 4).
- Trigger input signal can be assigned either on Camera Link connector (CC1) or on the No. 2 pin of the IO connector through the camera setting communication.

IO Signal Patterns

	Command No.		HR10A-7R-6PB (Hirose)			
	F0H[3..0]	11H[7]	No.2 Pin	No.3 Pin	No.4 Pin	No.5 Pin
			I/O-1 (SP4)	I/O-2 (SP3)	I/O-3 (SP2)	I/O-4 (SP1)
Option 0 (Initial Setting)	0H	0 (initial setting)	IN/TRG	IN/-	IN/-	OUT/ STROBE
		1	IN/TRG	OUT/VD	OUT/HD	OUT/ STROBE
Option 1	1H	-	For Test Use Only			
Option 2	2H	-	OUT/CC4	OUT/CC3	OUT/CC2	OUT/CC1
Option 3	3H	-	OUT/FVAL	OUT/XSG	OUT/XSUB	OUT/CC1
Option 4	4H	-	OUT/FVAL	OUT/LVAL	OUT/DVAL	OUT/PIC_D9 (MSB)
Option 5	5H	-	OUT/XHD (high-active)	OUT/EXPDUR (Exposure)	OUT/TRG	OUT/CC1
Option 6	6H	-	OUT/VD	N/A	N/A	OUT/HD
Others	7H-FH	-	For Test Use Only			

2 Camera Output Timing Charts

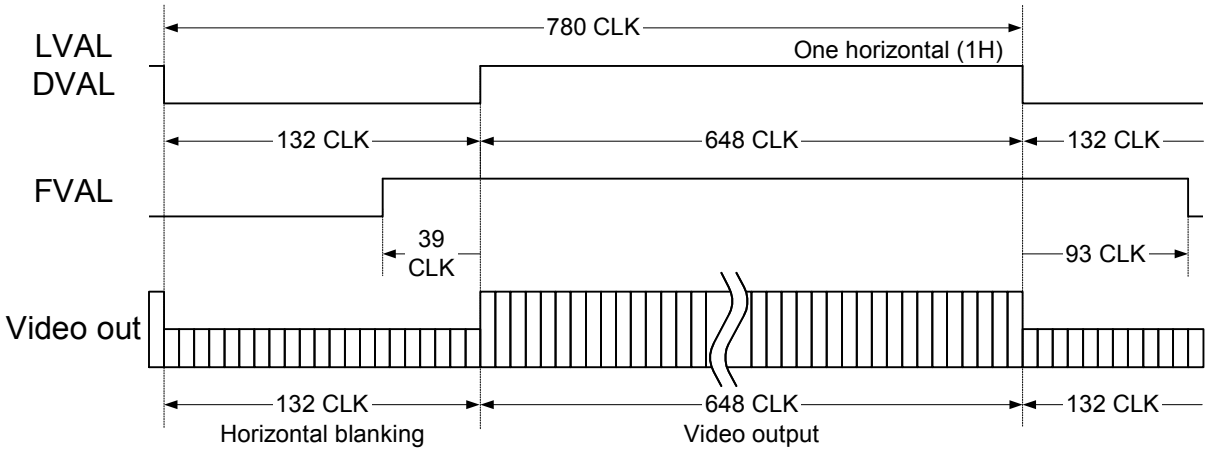
2.1 Normal Mode (Setting 10H: 1XX0XXXX)

	Normal Full Scanning			Partial Full Scanning			1/2 Partial Scanning			1/4 Partial Scanning		
Clock Speed (MHz)	Normal	x2/3	x1/3	Normal	x2/3	x1/3	Normal	x2/3	x1/3	Normal	x2/3	x1/3
Frame Rate (Hz)	89.9 (90)	59.4 (60)	29.9 (30)	94.4	62.9	31.5	180.1	120.1	60.1	360.3	240.2	120.1

※Clock Speed: 36.8181 MHz（Normal）、24.5454 MHz（x2/3）、12.2727 MHz（x1/3）

2.1.1 Horizontal Timing

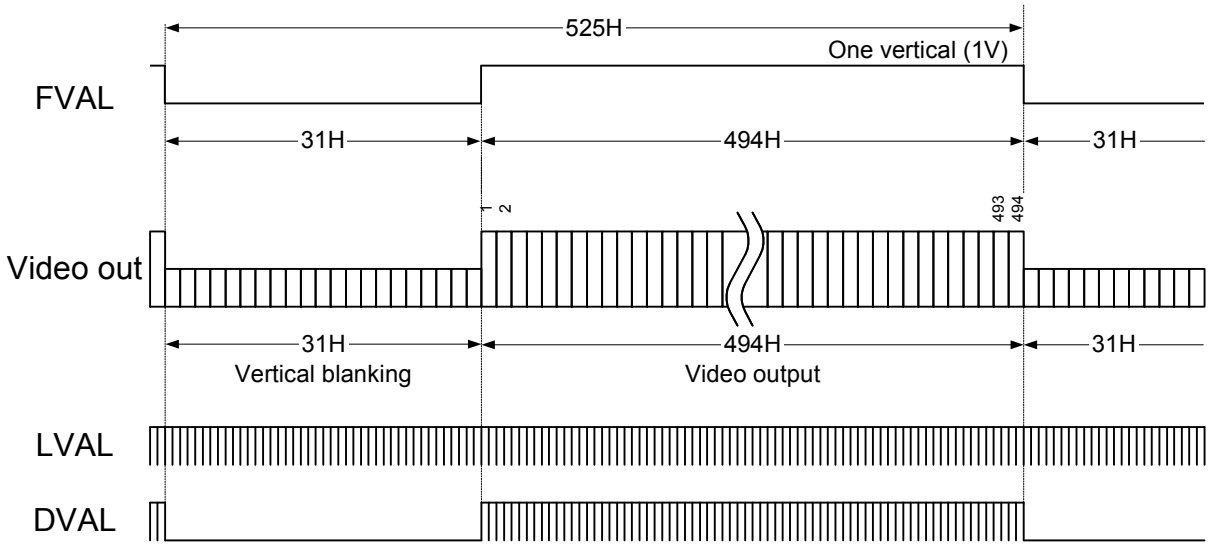
1 CLK = 81.4816 ns at 30fps
1 CLK = 40.7408 ns at 60fps
1 CLK = 27.1605 ns at 90fps



2.1.2 Vertical Timing

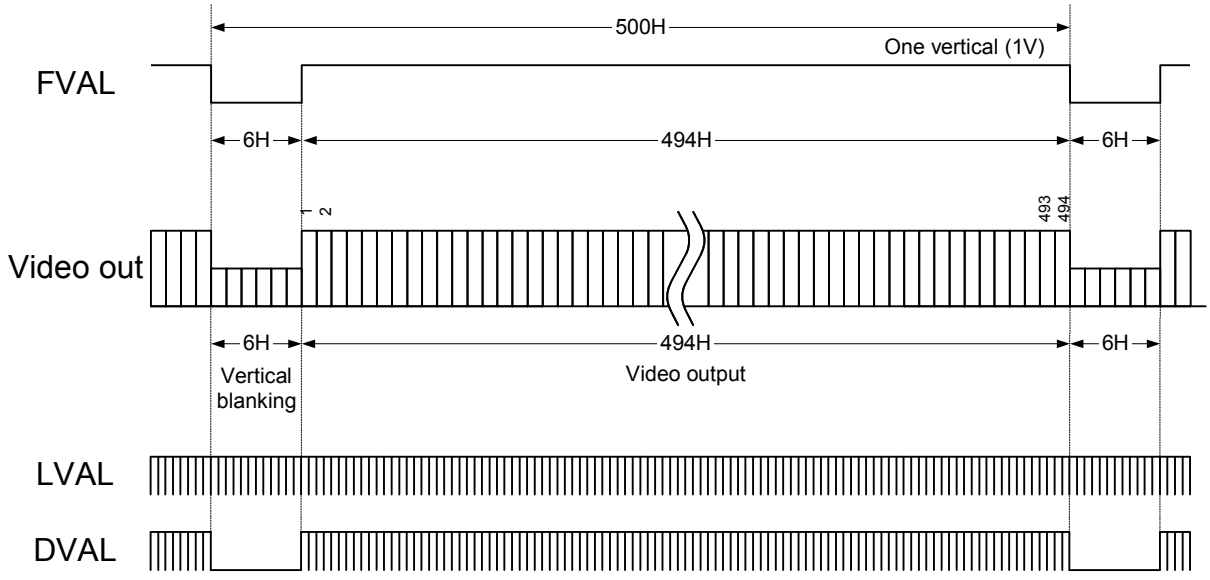
2.1.2.1 Normal Full Scanning (setting 10H: 1XX00XXX, 11H: XXX0X000)

1 H = 63.5556 μs, 29.9700 Hz at 30fps
1 H = 31.7778 μs, 59.9400 Hz at 60fps
1 H = 21.1852 μs, 89.9100 Hz at 90fps



2.1.2.2 Partial Full Scanning (setting 10H: 1XX01XXX, 11H: XXX0X000)

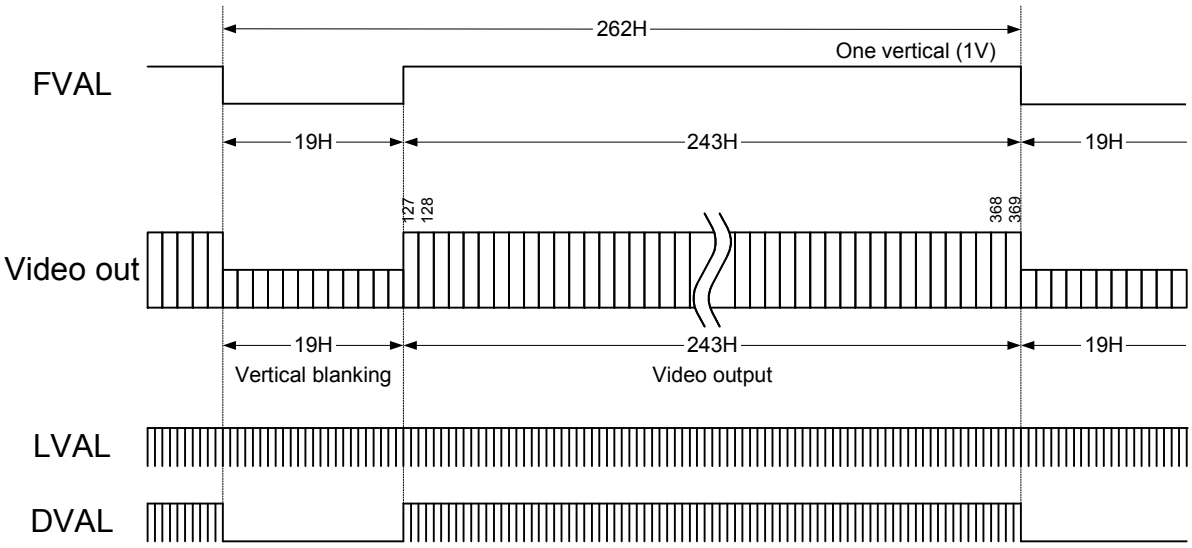
1 H = 63.5556 μs, 31.4685 Hz at 30fps
1 H = 31.7778 μs, 62.9370 Hz at 60fps
1 H = 21.1852 μs, 94.4055 Hz at 90fps



※ By transferring the blanking period pixels at a high rate, the frame rate of the partial full scanning can be increased compared to that of the normal full scanning.

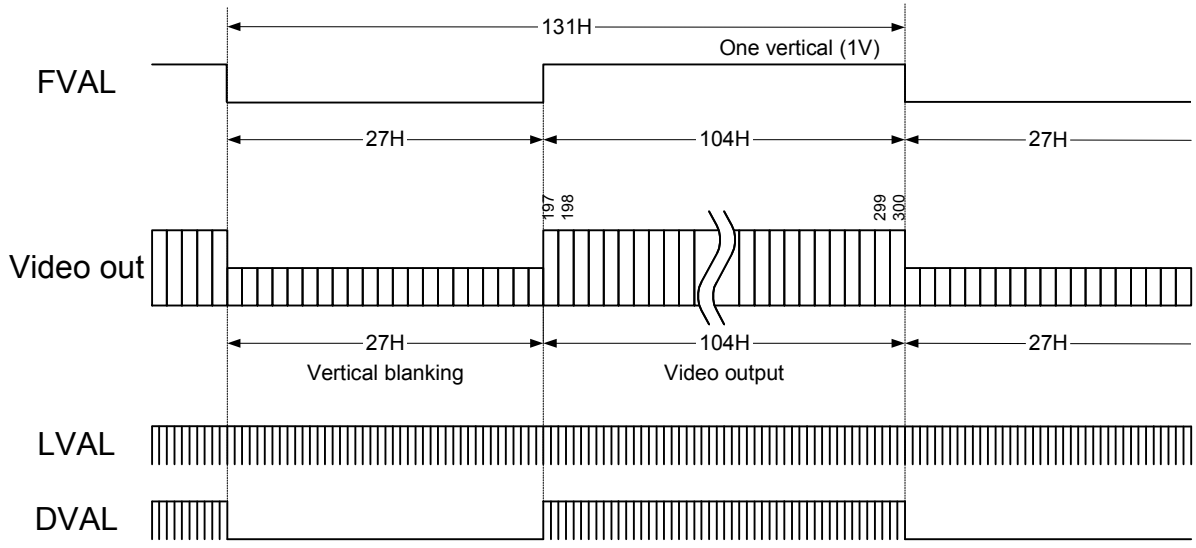
2.1.2.3 1/2 Partial Scanning (setting 10H: 1XX01XXX, 11H: XXX0X001)

1 H = 63.5556 μs, 60.0544 Hz at 30fps
1 H = 31.7778 μs, 120.108 Hz at 60fps
1 H = 21.1852 μs, 180.163 Hz at 90fps

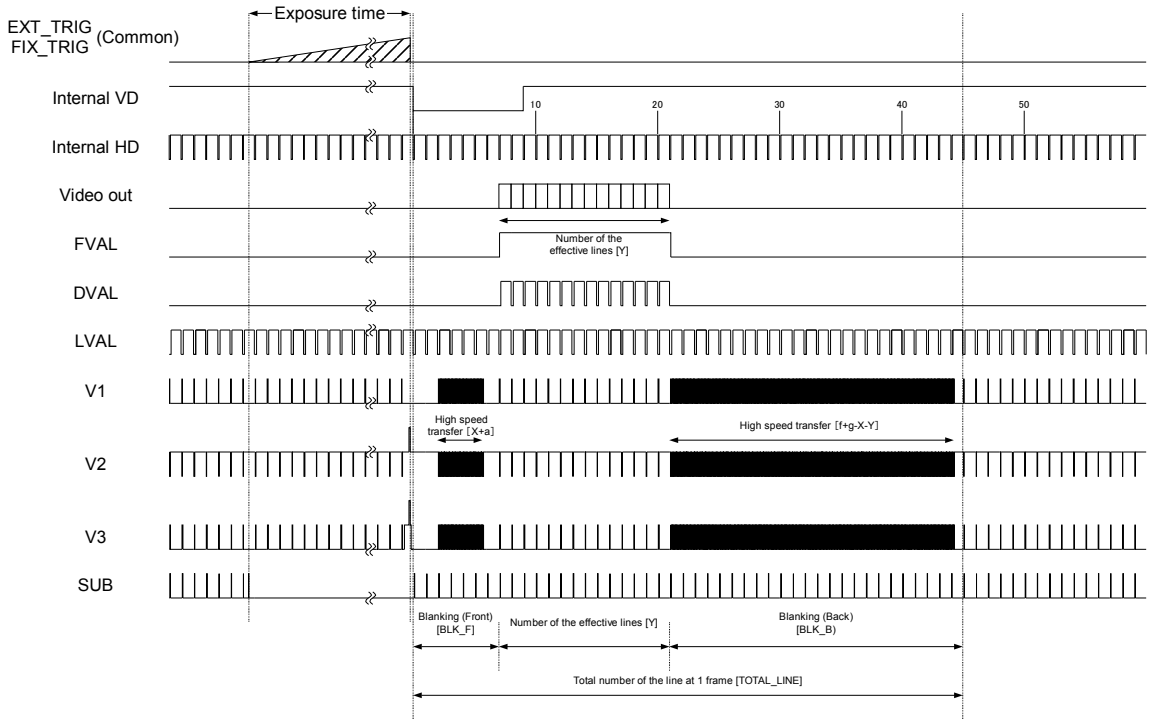


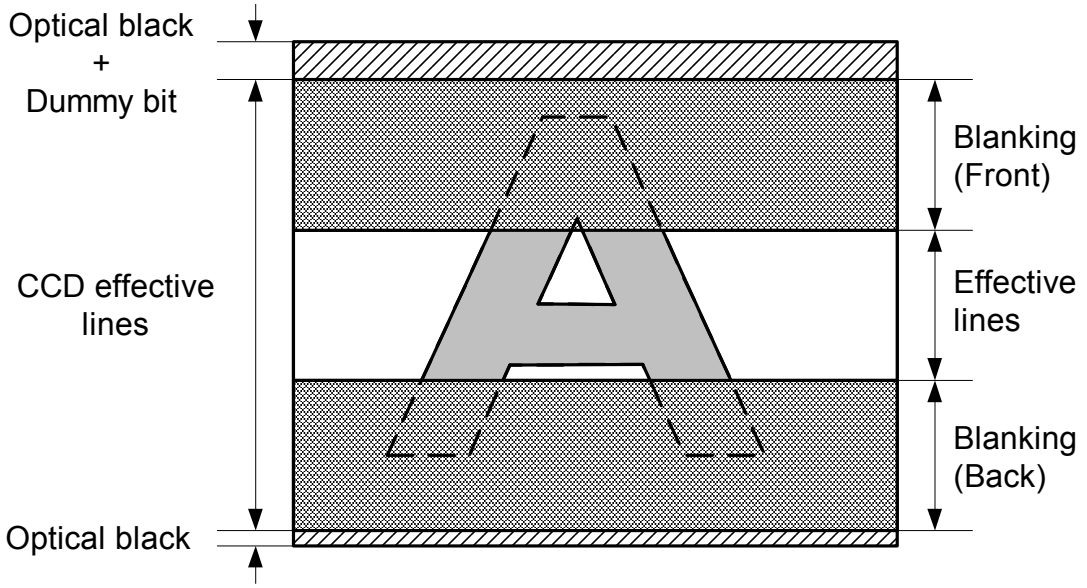
2.1.2.4 1/4 Partial Scanning (setting 10H: 1XX01XXX, 11H: XXX0X010)

1 H = 63.5556 μs, 120.108 Hz at 30fps
1 H = 31.7778 μs, 240.217 Hz at 60fps
1 H = 21.1852 μs, 360.326 Hz at 90fps



2.1.2.5 Variable Partial Scanning (Setting 10H: 1XX01XXX, 11H: XXX0X111)





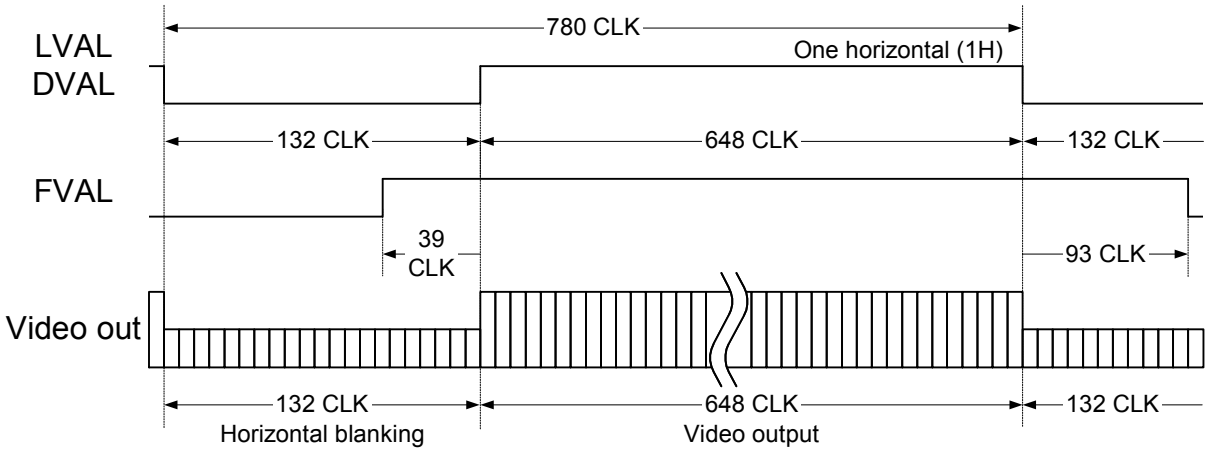
2.2 Binning Mode (setting 10H: 1XX1XXXX)

	Binning Full Scanning			Binning Partial Full Scanning			Binning 1/2 Partial Scanning			Binning 1/4 Partial Scanning		
Clock Speed (MHz)	Normal	x2/3	x1/3	Normal	x2/3	x1/3	Normal	x2/3	x1/3	Normal	x2/3	x1/3
Frame Rate (Hz)	180.2	120.1	60.1	186.6	124.4	62.2	337.2	224.8	112.4	597.5	398.3	199.2

※Clock Speed: 36.8181 MHz（Normal）、24.5454 MHz（x2/3）、12.2727 MHz（x1/3）

2.2.1 Horizontal Timing

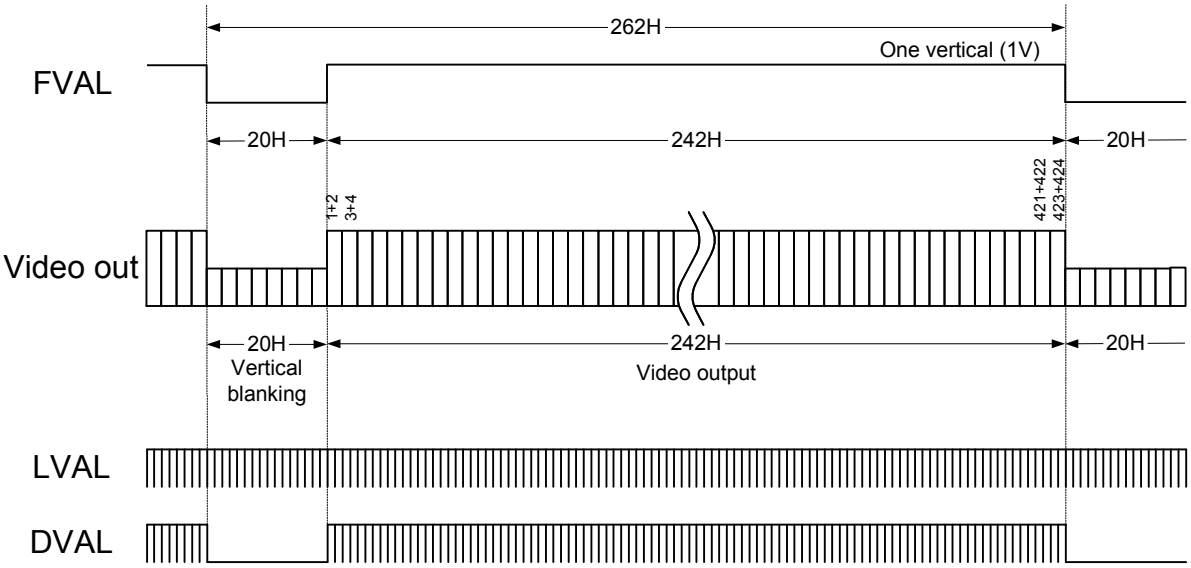
1 CLK = 81.4816 ns at 30fps
1 CLK = 40.7408 ns at 60fps
1 CLK = 27.1605 ns at 90fps



2.2.2 Vertical Timing

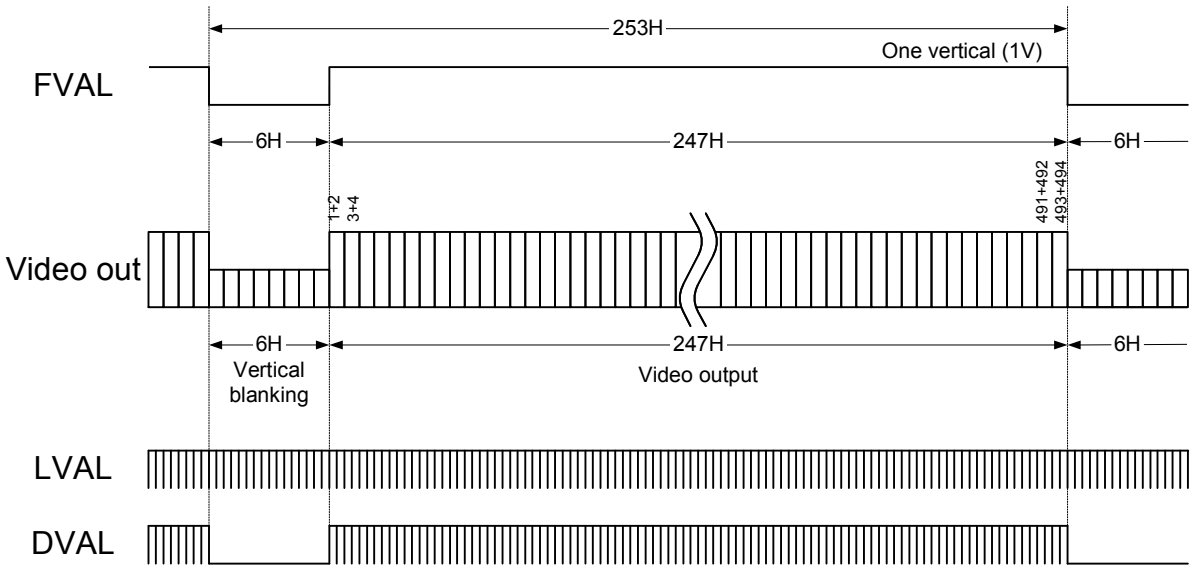
2.2.2.1 Binning Full Scanning (setting 10H: 1XX10XXX, 11H: XXX0X000)

1 H = 63.5556 μs, 60.0544 Hz at 30fps
1 H = 31.7778 μs, 120.108 Hz at 60fps
1 H = 21.1852 μs, 180.163 Hz at 90fps



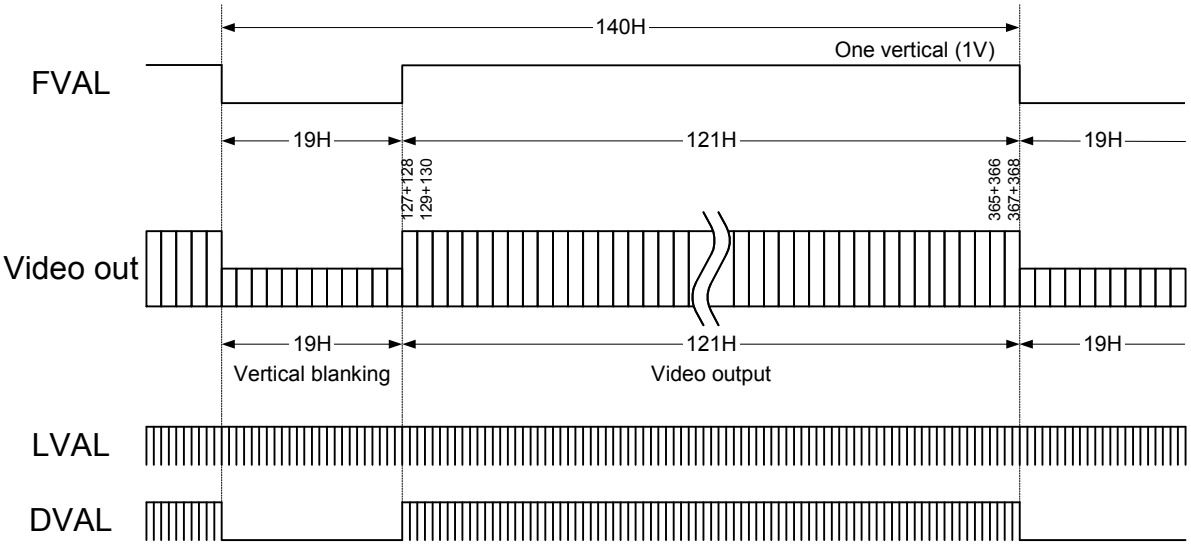
2.2.2.2 Binning Partial Full Scanning (setting 10H: 1XX11XXX, 11H: XXX0X000)

1 H = 63.5556 μs, 62.1907 Hz at 30fps
1 H = 31.7778 μs, 124.381 Hz at 60fps
1 H = 21.1852 μs, 186.572 Hz at 90fps



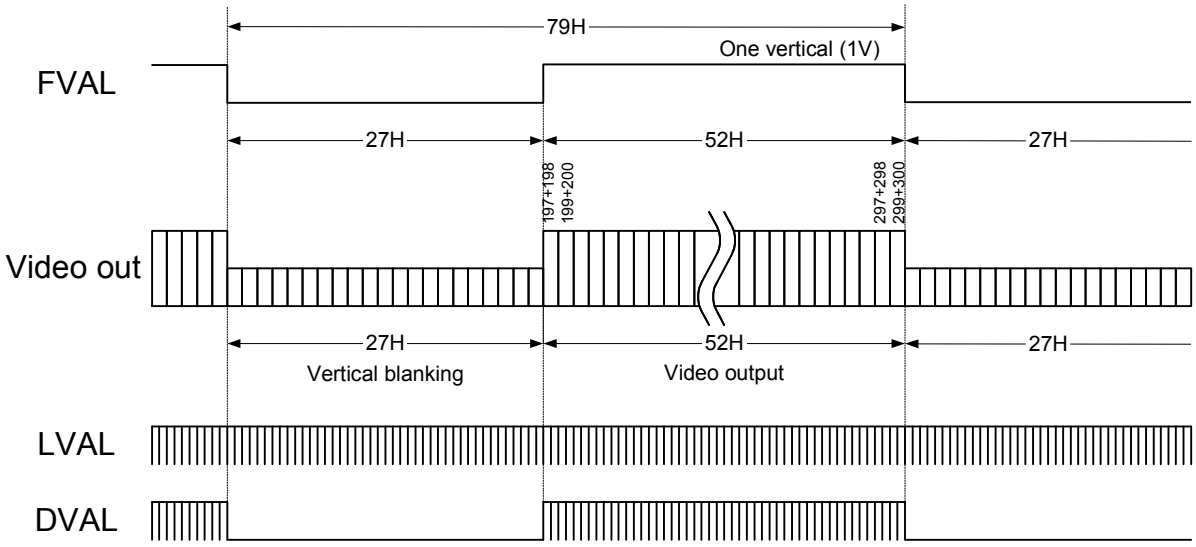
2.2.2.3 Binning 1/2 Partial Scanning (setting 10H: 1XX11XXX, 11H: XXX0X001)

1 H = 63.5556 μs, 112.378 Hz at 30fps
1 H = 31.7778 μs, 224.775 Hz at 60fps
1 H = 21.1852 μs, 337.162 Hz at 90fps

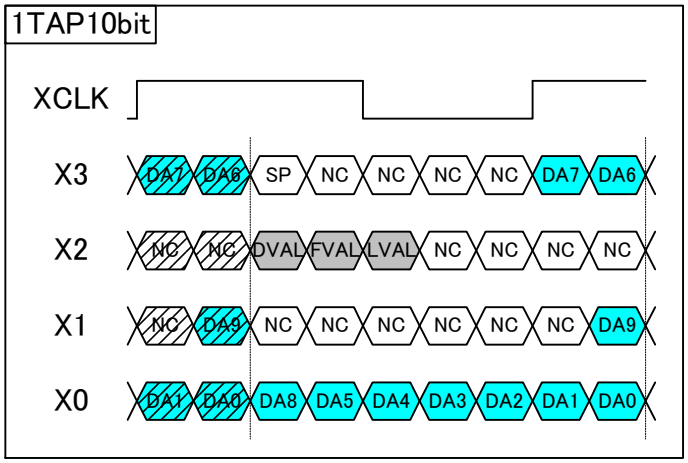


2.2.2.4 Binning 1/4 Partial Scanning (setting 10H: 1XX11XXX, 11H: XXX0X010)

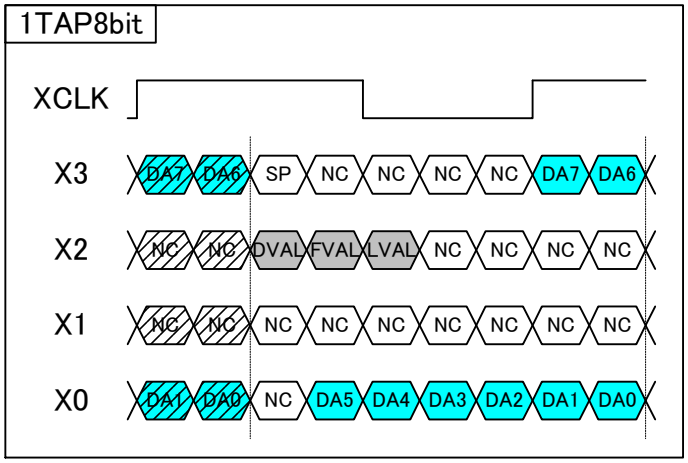
1 H = 63.5556 μs, 199.167 Hz at 30fps
1 H = 31.7778 μs, 398.335 Hz at 60fps
1 H = 21.1852 μs, 597.503 Hz at 90fps



2.3 Data Order on the Camera Link Output

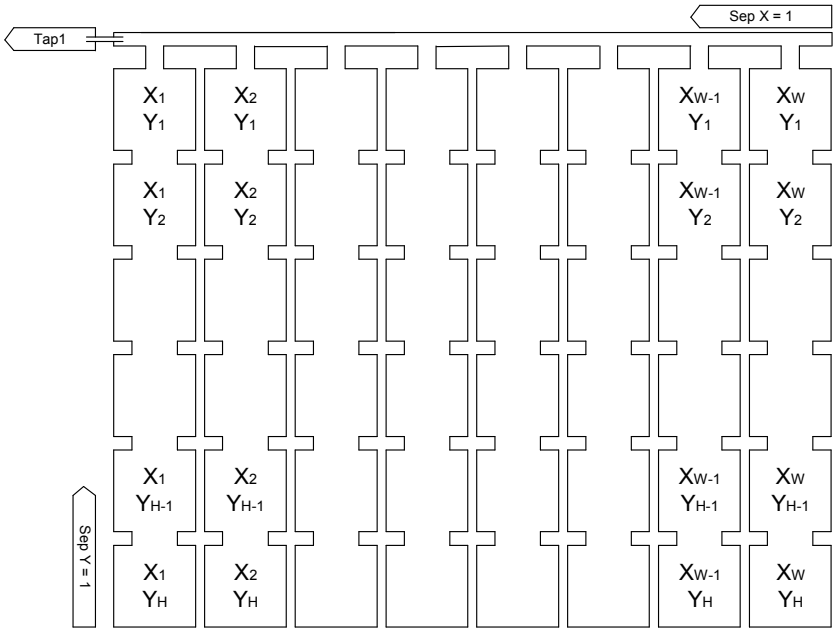


DA0～DA9: 10 bit data for one pixel

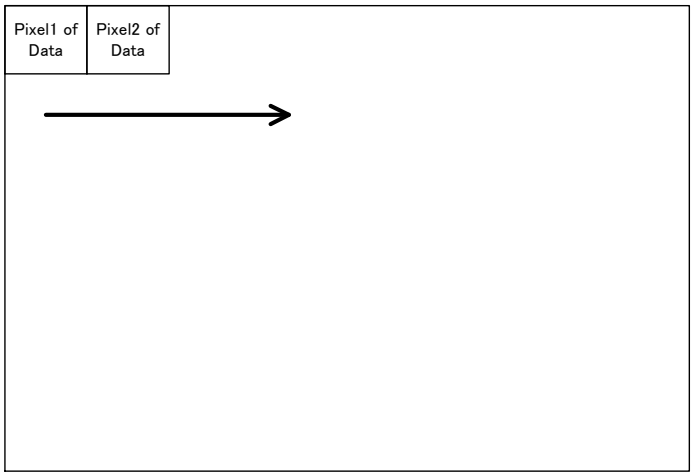


DA0～DA7: 8bit data for one pixel

2.4 1 Taps Transferring Image（1X-1Y）



2.5 Pixel Transferring Image



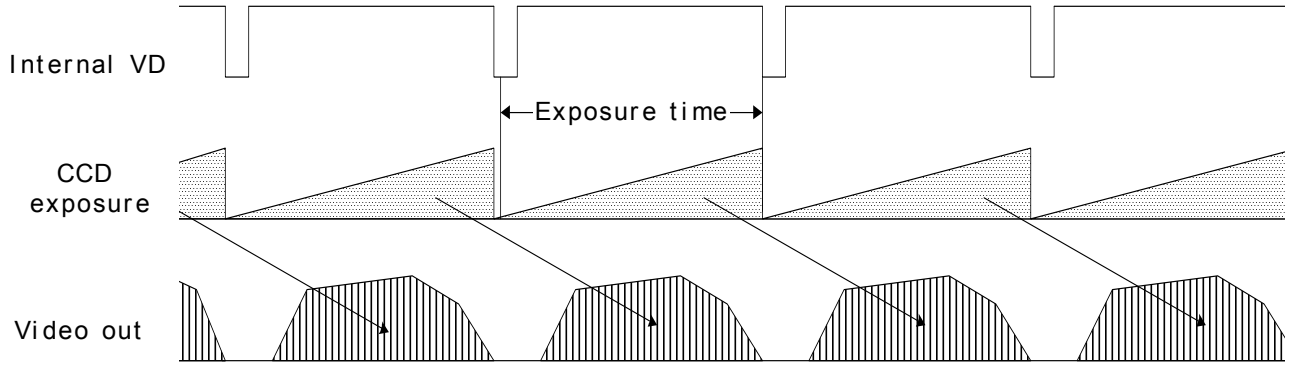
Pixeln of Data: nth pixel being transferred

3 Camera Operational Mode

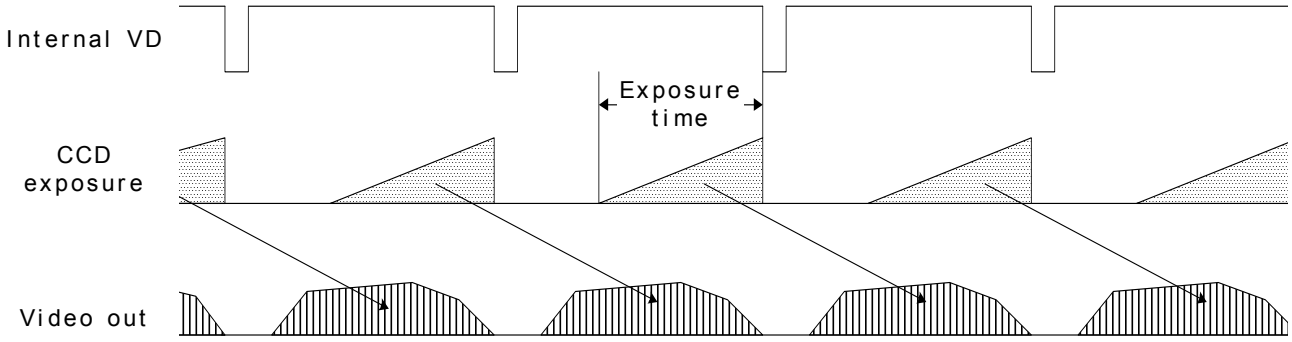
3.1 Normal Mode

In this mode, the images are output continuously.

3.1.1 Frame Exposure



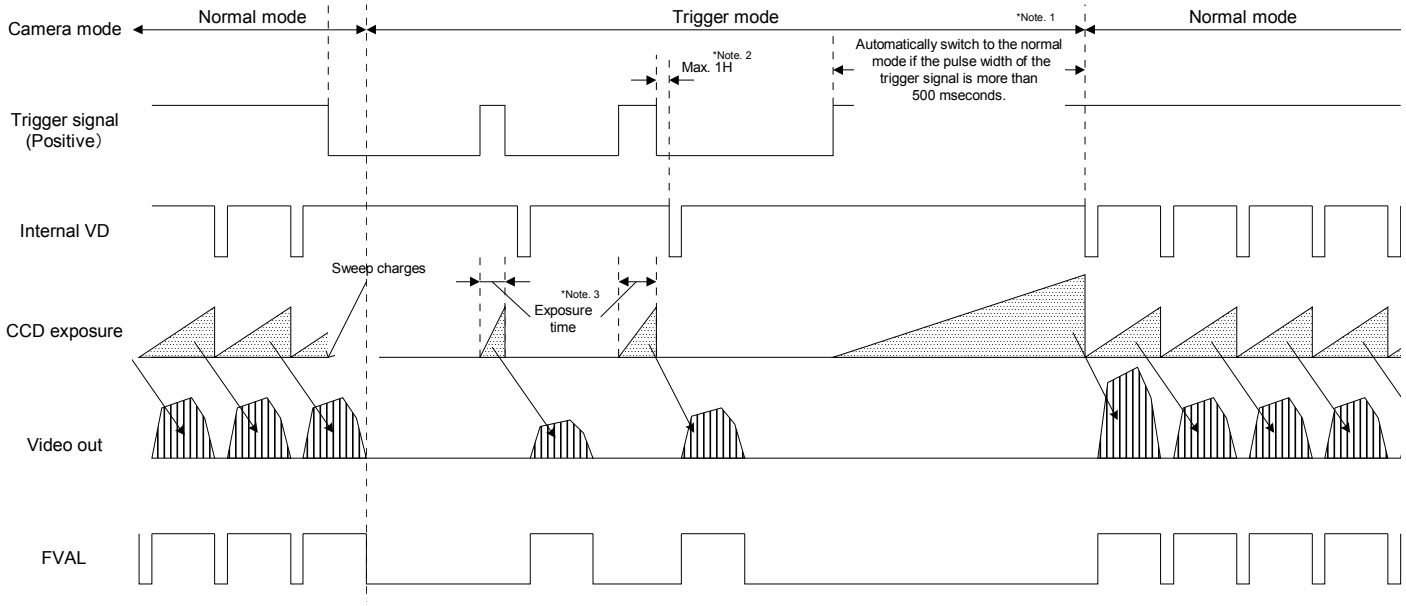
3.1.2 Electric Shutter



3.2 Pulse Width Trigger Mode

In this “pulse width trigger mode” with positive polarity, the camera exposure starts at the rising edge of the trigger signal and stops at the falling edge of the trigger signal. Therefore, in the case that the exposure positive polarity is selected, the actual exposure occurs when the trigger signal is at high state.

3.2.1 Pulse Width Trigger Mode（V-Reset）

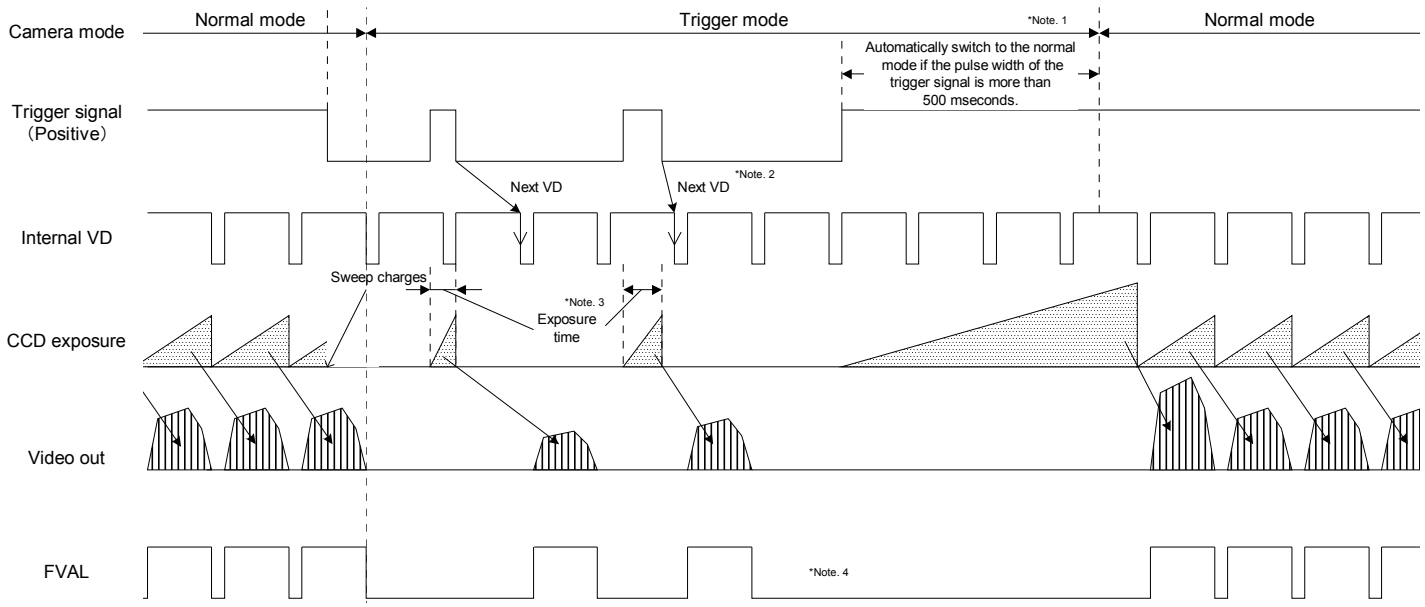


Note 1: The camera does NOT switch to normal mode when the long exposure mode is selected. This timing chart shows when the long exposure mode selected.

Note 2: The internal VD signal is reset immediately after the exposure is finished as depicted, and the video output original is sent out according to that reset VD timing.

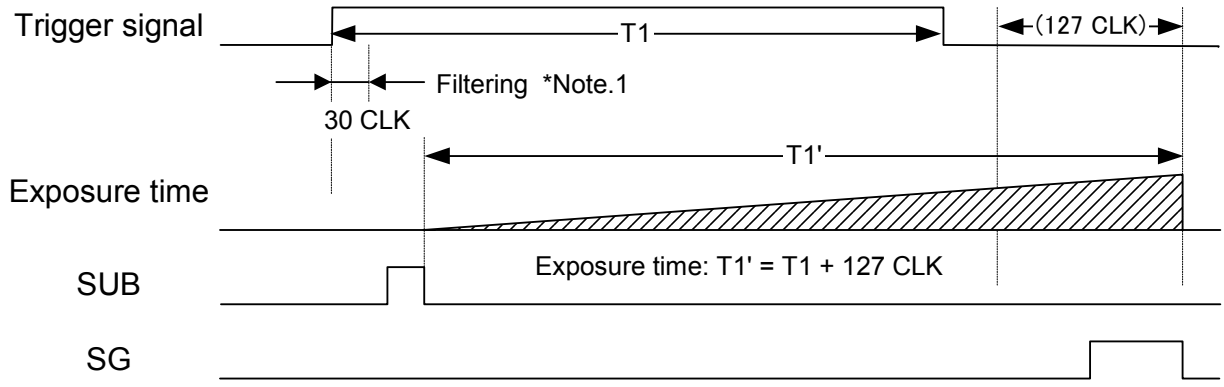
Note 3: The exposure time is controlled by the pulse width of the trigger signal as depicted.

3.2.2 Pulse Width Trigger Mode (Non-Reset)



Note 1: The camera does NOT switch to normal mode when the long exposure mode is selected.
This timing chart shows with the long exposure mode selected.
Note 2: The internal VD signal does not reset by the trigger signal.
The video output signal is sent out at the next internal VD timing.
Note 3: The exposure time is controlled by the pulse width of the trigger signal as depicted.
Note 4: The FVAL signal does not output when the exposure by the trigger signal does not exists.

3.2.3 Exposure Timing

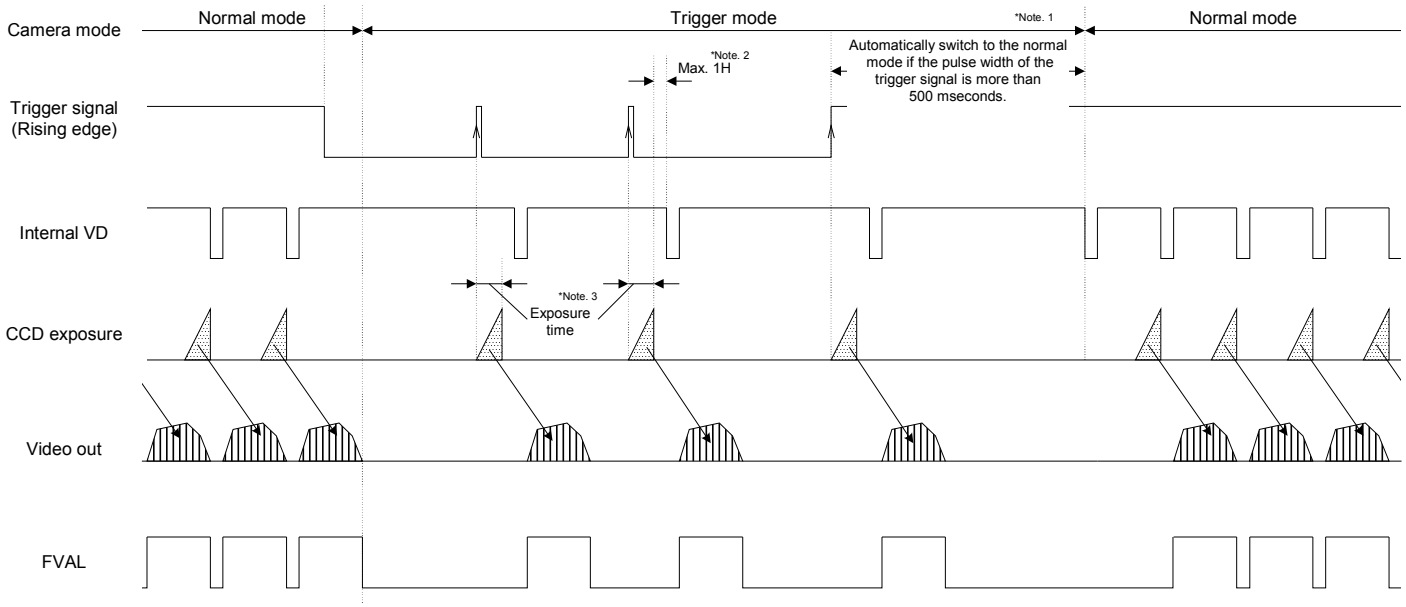


Notes: The trigger signal equal to or shorter than 30 CLK is removed by the filtering system.
Input trigger signal has to be more than 31 CLK pulse width.
The exposure starts 63 CLK after the rising edge of the trigger signal.

3.3 Edge Preset Trigger Mode

In this “edge preset trigger mode”, the camera exposure starts at the rising edge of the trigger signal like the “pulse width trigger mode” in the previous sections. However, in this mode, the exposure duration time is based on the preset value stored by the by the camera setting communication.

3.3.1 Edge Preset Trigger Mode (V-Reset)

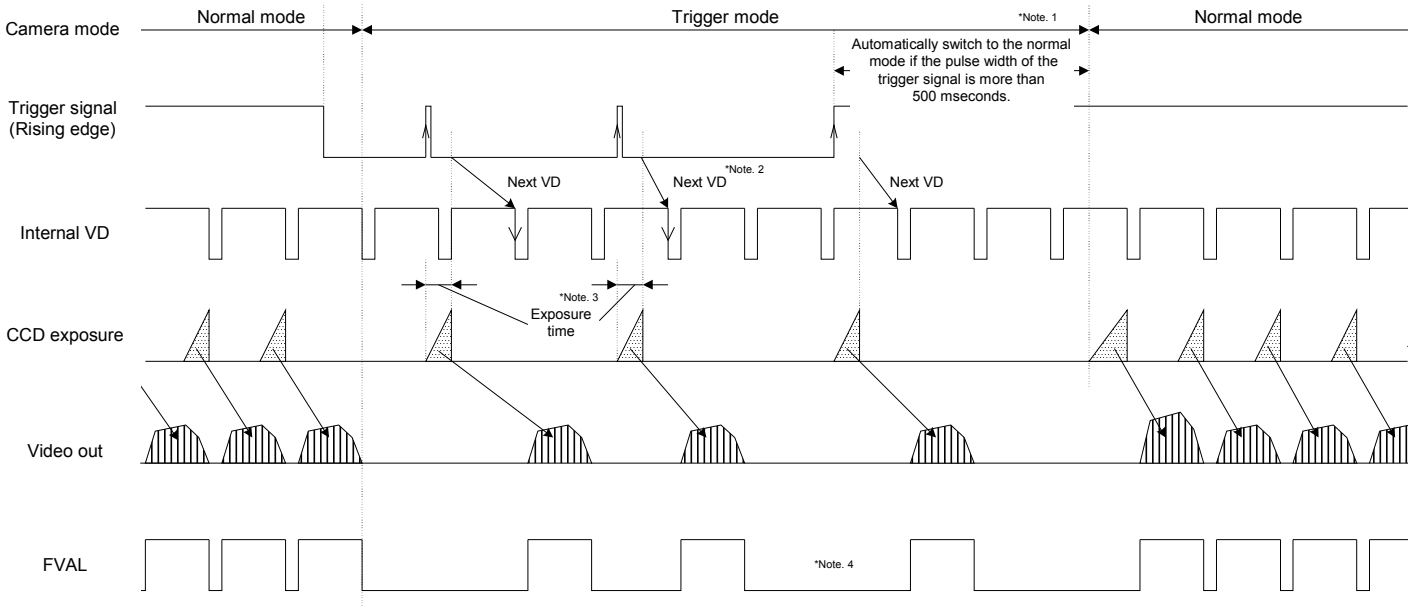


Note 1: The camera does NOT switch to the normal mode when the long exposure mode is selected. This timing chart shows when the long exposure mode is selected.

Note 2: The internal VD signal is reset immediately after the exposure is finished as depicted and the video output signal is sent out according to the reset VD timing.

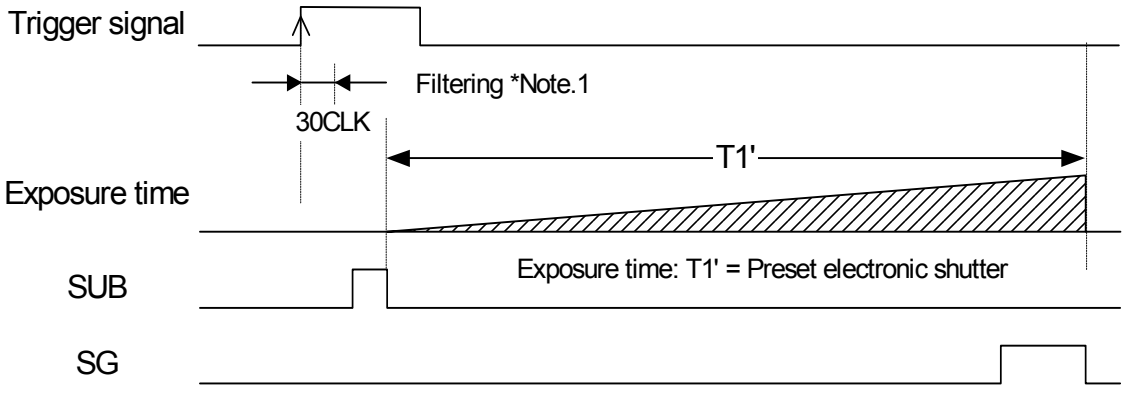
Note 3: The exposure time is preset by the camera setting communication as “shutter speed”.

3.3.2 Edge Preset Trigger Mode (Non-Reset)



Note 1: The camera does NOT switch to normal mode when the long exposure mode is selected.
This timing chart shows when the long exposure mode selected.
Note 2: The internal VD signal does not reset by the trigger signal.
The video output signal is sent out at the next internal VD timing.
Note 3: The exposure time is preset by the camera setting communication as “shutter speed”.
Note 4: The FVAL signal does not output when the exposure by the trigger signal does not exists.

3.3.3 Exposure Timing

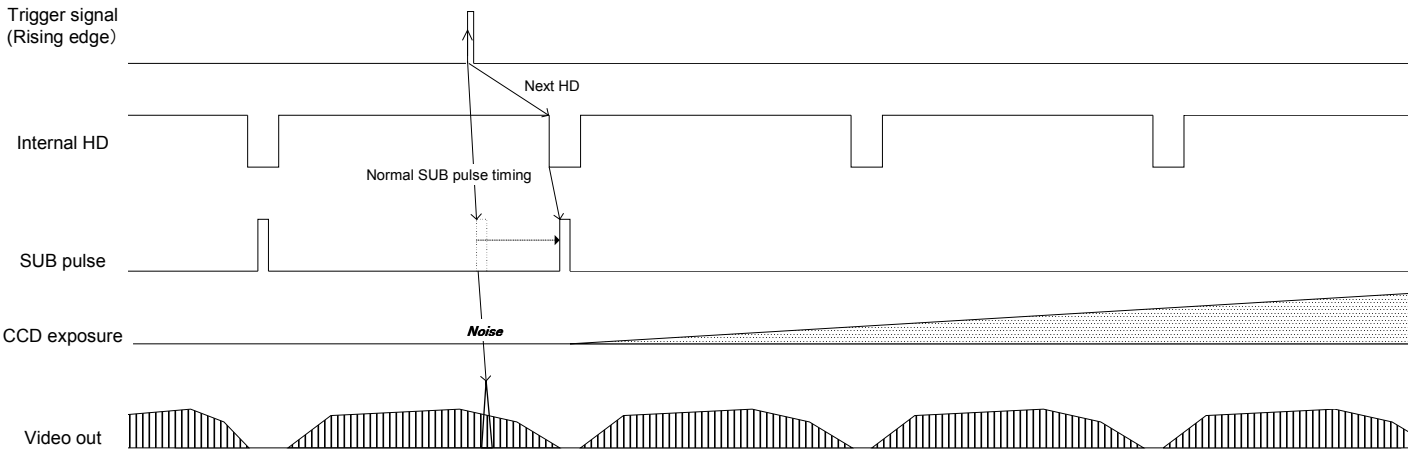


Notes: The trigger signal equal to or shorter than 30 CLK is removed by the filtering system.
Input trigger signal has to be more than 31 CLK pulse width.
The exposure starts 63 CLK after the rising edge of the trigger signal.

3.4 H Reset Mode

Normally, video noise appears when the beginning of trigger signal is applied before finishing the video read-out of the previous frame. This noise is caused by the SUB pulse, which is activated to clear all residual charges on the CCD prior to a new exposure. By selecting this “H. Reset Mode”, the camera automatically holds the actual activation of trigger until the next horizontal blanking period. By doing this, the SUB pulse is activated during the horizontal blanking period and the noise in image can be avoided.

Note: Due to the principal of this operation, there can be maximum “1 H” of delay of actual trigger signal.



4 Communication Protocol

This camera has a communication function that enables external devises, such as a PC, to control the camera's functions.
Please use the "R-CLinkCtrl" communication software, or the following communication protocol to communicate to the camera:

4.1 Communication Method

UART（RS232C）, binary communication

4.2 Communication Settings

	Settings
Baud Rate	9,600 bps / 38,400 bps / 57,600 bps / 115,200 bps
Data Bit	8 bit
Parity	None
Stop Bit	1 bit
Flow Control	None

4.3 Communication Format

The Sending data format from the PC to the camera is as follows:

SOF	Device Code	Read/Write	Page Selection	Command Code	Data Length	Data	EOF
(8bit)	(6bit)	(1bit)	(1bit)	(8bit)	(8bit)	(R: 1 byte) (W: n bytes)	(8bit)

The Receiving Data format from the camera is as follows:

- After sending the Read Command:

SOF	Data Length	Data	EOF
(8bit)	(8bit)	(n bytes)	(8bit)

- After sending the Write Command:

SOF	Data Length	Receiving Code	EOF
(8bit)	(8bit) "00"	(1 byte)	(8bit)

The description of the format is as follows.

Name	Descriptions
SOF	Start of Frame. Always set or receive the value as “02H”
Device Code	This indicates the destination of communication. Set “000000” when accessing the camera’s function settings Set “100000” when accessing the camera’s extended function settings. Please refer to the “Camera Command List” and “Description of the Camera Control Commands”.
Read / Write	This specifies “Read” or “Write” to command numbers. Set (or receive) “0” to send the read command. Set (or receive) “1” to send the write command.
Page Selection	This specifies page selection (access selection to registers or EEPROM) of command. Set “0” to access the command register of the camera. Read command: To obtain the current data from the command register. Write command: To set a data into the command register. The previously stored data is replaced by this data. However, the data in the EEPROM is not replaced. Set ”1” to access the EEPROM of the camera. Read command: To read stored data from the EEPROM. Write command: To store data into the EEPROM as default value. The camera returns the receiving code “01H” to the PC after storing data in the EEPROM.
Command Code	This indicates the contents of the data sent or received. Refer to the following page for the details.
Data Length	This indicates the data length (unit: byte). Receiving Frame: The data length is dependent on each read command sent. The data length is defined as “00H” when sending the write command. The data length of error response is defined as “00H”. Sending frame: The data length is 1 byte dummy data when sending the read command, and that data is not referenced. The data length is dependent on each “write command” sent.
Data	This indicates write data or read data according to command type.
EOF	End of Frame. Always set or receive the value as “03H”
Receiving Code	This indicates results of the command sent 01H: OK (ACK), 10H: NG (NAC), 11H: Connection error with peripheral device 12H: Command number error (Not matching), 13H: Communication frame error, 14H: Time out error, 17H: EEPROM write error

【Example Code】Reading the data from the command 00H

- Command to send: 02H, 00H, 00H, 01H, 00H, 03H

SOF	Device Code	Read/Write	Page Selection	Command Code	Data Length	Data	EOF
(8bit)	(6bit)	(1bit)	(1bit)	(8bit)	(8bit)	(1byte)	(8bit)
02H	**00H**			**00H**	**01H**	**00H**	**03H**

- Command to receive upon a successful communication: 02H, 01H, 00H, 03H (assuming the data is 00H)

SOF	Data Length	Data	EOF
(8bit)	(8bit)	(n bytes)	(8bit)
02H	**01H**	**00H**	**03H**

【Sequence for the saving commands to the EEPROM】

Please use the following sequence for saving the commands to the EEPROM.

1) Set “1” to the 80H.0 to enable writing to the EEPROM.

2) Send the save data with the page selection “1”.

3) The camera sends back one of the following receiving codes after writing the EEPROM.
   01H: OK
   17H: EEPROM write error

4) 80.0H is cleared to “0” automatically after writing the EEPROM.

Note1: The data cannot be saved to the EEPROM when 80H.0 is “0”.

Note2: When saving the consecutive sequence of commands, the above steps, 1) to 4), are necessary only once.

i.e.) saving the commands “10H, 11H, 12H, 13H”, or “22H, 23H, 24H”, etc.

Note3: When saving the non-consecutive sequence of commands, the above steps, 1) to 4), are necessary for the same number of times.

i.e.) saving the commands “10H, 13H, 19H, 1BH” or “20H, 23H, 25H”, etc.

4.4 Camera Control Command

4.4.1 Camera Command List

- The data unit of the each command is 1 byte (8bit).
- The data can be saved to the EEPROM if there is an “X” in the “Save to EEPROM” column in the following list.
- The camera initializes based on the stored data in the EEPROM when the power is applied.

Command No.	R/W	Save to EEPROM	Function	Initial Data	Data Range
00 to 0FH			*Reserved*	-	-
10H	R/W	X	*Camera function mode 1 (8bit: D[7…0])*	9	0 to 255
11H	R/W	X	*Camera function mode 2 (8bit: D[7…0])*	32 (20H)	0 to 255
12H	R/W	X	*Camera function mode 3 (8bit: D[7…0])*	0	0 to 255
13H			*Reserved*	-	-
14H	R/W	X	*Communication mode (8bit: D[7…0])*	1	0 to 3
15 to 1BH			*Reserved*	-	-
1CH	R/W	X	*AGC max (8bit: D[7…0])*	255 (FFH)	0 to 255
1DH	R/W	X	*ALC luminance target level (8bit: D[7…0])*	128 (80H)	0 to 255
1EH	R/W	X	*ALC mode (8bit: D[7…0])*	0	0 to 3
20H	R/W	X	*Exposure time (H) of the electronic shutter (16bit: D[7…0])*	0	0 to 4095
21H	R/W	X	*Exposure time (H) of the electronic shutter (16bit: D[15…8])*		
22H	R/W	X	*Exposure time (CLK) of the electronic shutter (16bit: D[7…0])*	0	0 to 779
23H	R/W	X	*Exposure time (CLK) of the electronic shutter (16bit: D[15…8])*		
24H	R/W	X	*Start line of the variable partial scanning (16bit: D[7…0])*	0	0 to 493
25H	R/W	X	*Start line of the variable partial scanning (16bit: D[15…8])*		
26H	R/W	X	*Effective lines of the variable partial scanning (16bit: D[7…0])*	494 (1EEH)	0 to 494
27H	R/W	X	*Effective lines of the variable partial scanning (16bit: D[15…8])*		
28H	R/W	X	*Delay time for the trigger (16bit: D[7…0])*	0	0 to 65535
29H	R/W	X	*Delay time for the trigger (16bit: D[15…8])*		
2A-2FH			*Reserved*	-	-
30H	R/W	X	*CDS gain (8bit: D[7…0])*	0	0 to 255
31H	R/W	X	*Digital gain*	The Factory Adjusted Value	0 to 255
32H	R/W	X	*Gain offset (8bit: D[7…0])*		0 to 255
33 to 37H			*Reserved*	-	-
38H	R/W	X	*Clamp level (8bit: D[7…0])*	0	0 to 31
39 to 3DH			*Reserved*	-	-
3EH	R/W	X	*Test pattern level (10bit: D[7…0])*	768 (300H)	0 to 1023
3FH	R/W	X	*Test pattern level (10bit: D[9…8])*		
40 to 53H	R/W	X	*Reserved*	-	-
54H	R/W	X	*Strobe Delay (us) (24bit: D[7..0])*	0	0 to 2000000
55H	R/W	X	*Strobe Delay (us) (24bit: D[15..8])*		
56H	R/W	X	*Strobe Delay (us) (24bit: D[23..16])*		
57H		X	*Reserved*	-	-
58H	R/W	X	*Strobe polarity (8bit: D[7…0])*	0	0 to 1
59 to 77H		X	*Reserved*	-	-

Command No.	R/W	Save to EEPROM	Function	Initial Data	Data Range
78H	R/W	X	*Test pattern selection (8bit: D[7..0])*	0	0 to 31
79H	R/W	X	*Image effect selection (8bit: D[7..0])*	0	0 to 255
7A to 7FH			*Reserved*		
80H	R/W		*EEPROM control (8bit: D[7…0])*	0	0 to 1
81 to 8FH			*Reserved*	-	-
94H	R/W	X	*Strobe active period (us) (24bit: D[7..0])*	0	0 to 2000000
95H	R/W	X	*Strobe active period (us) (24bit: D[15..8])*		
96H	R/W	X	*Strobe active period (us) (24bit: D[23..16])*		
97 to 9FH			*Reserved*	-	-
A0H	W	X	*Pixel defect correction mode (8bit: D[7..0])*	0	0 to 7
A1H	W	X	*Pixel defect correction index number(8bit: D[7..0])*	0	0 to 15
A2H	W	X	*PDC X coordinate (Write) (16bit: D[7..0])*	0	0 to 65535
A3H	W	X	*PDC X coordinate (Write) (16bit: D[15..8])*		
A4H	W	X	*PDC Y coordinate (Write) (16bit: D[7..0])*	0	0 to 65535
A5H	W	X	*PDC Y coordinate (Write) (16bit: D[15..8])*		
A6H	R	X	*PDC X coordinate (Read) (16bit: D[7..0])*	0	-
A7H	R	X	*PDC X coordinate (Read) (16bit: D[15..8])*		
A8H	R	X	*PDC Y coordinate (Read) (16bit: D[7..0])*	0	-
A9H	R	X	*PDC Y coordinate (Read) (16bit: D[15..8])*		
AA –BFH			*Reserved*	-	-
C0H	R/W	X	*Auto exposure min (16bit: D[7..0])*	1	0 to 4095
C1H	R/W	X	*Auto exposure min (16bit: D[15..8])*		
C2H	R/W	X	*Auto exposure max (16bit: D[7..0])*	4095 (FFFH)	0 to 4095
C3H	R/W	X	*Auto exposure max (16bit: D[15..8])*		
C4H			*Reserved*	-	-
C5H	R/W	X	*Look-up table (Gamma) (8bit: D[7..0])*	0	0 to 6
C6H	R/W	X	*ALC Speed (8bit: D[7..0])*	0	0 to 255
C7 to EFH			*Reserved*	-	-
F0H	R/W		*IO connector signals1 (8bit: D[7…0])*	0	0 to 15
F1 to FFH			*Reserved*	-	-

4.4.2 Descriptions of the Camera Control Commands

(The underline settings are the factory default settings)

<table>
<tr><th>Command No.</th><th>Command Descriptions</th></tr>
<tr><td>10H:
MOD1[7…0]</td><td>[Camera function mode setting 1] Initial data: 09H
Sets the following camera function mode.
D[7…0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

<table>
<tr><td>D7:</td><td>Continuous / Trigger Mode</td><td>0: Auto</td><td>1: Manual</td></tr>
<tr><td>D6:</td><td>Trigger Polarity</td><td>0: Positive</td><td>1: Negative</td></tr>
<tr><td>D5:</td><td>Trigger Mode</td><td>0: Edge Preset</td><td>1: Pulse Width</td></tr>
<tr><td>D4:</td><td>Binning Mode</td><td>0: OFF (Normal)</td><td>1: ON (Binning)</td></tr>
<tr><td>D3:</td><td>Scanning Mode</td><td>0: Full scanning</td><td>1: Partial scanning</td></tr>
<tr><td>D2 to D0:</td><td>Reset Mode</td><td>000: Non-Reset</td><td>001: V-Reset</td></tr>
<tr><td></td><td></td><td colspan="2">010~111: No function
(Prohibited setting. Please do not use these)</td></tr>
</table>

When D7 is set to “0: Auto”, a camera will detect its operational mode based on the input trigger signal.
If the input trigger signal is kept at high, the camera operates in the continuous mode, assuming the trigger polarity is set to positive.</td></tr>
<tr><td>11H:
MOD2[7…0]</td><td>[Camera function mode setting 2] Initial data: 32 (20H)
Sets the following camera function modes.
D[7…0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

<table>
<tr><td>D7</td><td>HD / VD direction</td><td>00H: SP2 and SP3 as inputs</td><td>01H: SP2 and SP3 as outputs</td></tr>
<tr><td></td><td></td><td colspan="2">10 to 11H: (Prohibited setting. Do not set these values)</td></tr>
<tr><td>D6 to D5</td><td>Frame rate</td><td>00H: 60fps</td><td>01H: 90fps</td></tr>
<tr><td></td><td></td><td>10H: 30fps</td><td>11H: No function</td></tr>
<tr><td>D4</td><td>Smear Half Reduction</td><td>0: OFF</td><td>1: ON</td></tr>
<tr><td>D3</td><td>Function Mode</td><td>0: Trigger Mode</td><td>1: Continuous Mode</td></tr>
<tr><td>D2 to D0:</td><td>Partial Scanning</td><td>000: Full scanning</td><td>001: 1/2 partial scanning</td></tr>
<tr><td></td><td></td><td>010: 1/4 partial scanning</td><td>111: Variable partial scanning</td></tr>
<tr><td></td><td></td><td colspan="2">011~110: No function (Prohibited setting. Do not set these values)</td></tr>
</table>

Function mode is enabled when the “Continuous/Trigger” mode selection (MOD[7] is manual (set as 1).
No video output without the trigger signal input while the camera works with the trigger mode.</td></tr>
</table>

<table>
<tr><th>Command No.</th><th>Command Descriptions</th></tr>
<tr><td>12H:
MOD3[7…0]</td><td>[Camera function mode setting 3] Initial data: 0
Sets the following camera function modes.
D[7…0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7~D6: Video Out — 00: 10bit; 01: 8bit; 10: 12bit; 11: No function (Prohibited setting. Do not set these values)
D5: Trigger-in connector selection — 0: Camera Link (CC1); 1: /IO connector (No.2 Pin)
D4~D3: Exposure Start Mode — 00: Normal; 01: Reserved trigger; 10 ~11: H reset
D2~D1: No Function — Set always “000”
D0 Look-up table (Gamma) — 00: OFF; 01: ON</td></tr>
<tr><td>14H:
UART[7…0]</td><td>[Communication mode] Initial Data: 01H
Sets the communication modes.
D[7…0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7~D2: No Function — Set always “000000”
D1~D0: Communication Mode — 00: 38,400 bps; 01: 9,600 bps; 10: 57,600 bps; 11: 115,200 bps</td></tr>
<tr><td>1CH:
AGCMAX[7..0]</td><td>[AGC maximum limit] Initial data: 255, data range: 0 to 255
Sets the maximum limit for the AGC.</td></tr>
<tr><td>1DH:
ALCTRGT [7..0]</td><td>[Target Brightness for ALC] Initial data: 128, data range: 0 to 255
Sets the target brightness for the ALC function (Auto Luminance Control).</td></tr>
<tr><td>1EH:
ALCMODE[7..0]</td><td>[ALC mode] Initial data: 0
Sets the ALC modes.
D[7…0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7: Long exposure — 0: OFF; 1: ON
D6 to D2 No Function — Set always “00000”
D1 AGC (Auto Gain Control) — 0: OFF; 1: ON
D0 AE (Auto Exposure) — 0: OFF; 1: ON

When using AE combined with the long exposure, exposure time is controlled regardless of the frame rate. Therefore, the frame rate varies depending on the exposure time.</td></tr>
</table>

Command No.	Command Descriptions
20H: SVR[7…0] 21H: SVR[15…8]	[Exposure time (H) of the electronic shutter] Initial Data: SVR[15…0] = 0, Data Range: 0 to 4095 Sets the preset shutter speed (or CCD exposure time) for electronic shutter. The preset shutter speed is defined by the following formula. Exposure time (shutter speed) = SVR[15…0] x (1H cycle time) + SHR[15…0] x (1CLK cycle time) Notes: 1. The camera works with the shutter off position (maximum frame exposure time) when both SVR and SHR are set at “0”. 2. The camera works with the minimum shutter speed when this value is set to 0 and the value of SHR is set between 1 and 306. 3. The value is replaced with 4095 automatically when the value set greater than 4095.
22H: SHR[7…0] 23H: SHR[15…8]	[Exposure time (CLK) of the electronic shutter] Initial Data: SHR[15…0] = 0, Data Range: 0 to 779 Sets the preset shutter speed (or CCD exposure time) for electronic shutter. The previous section, the preset shutter speed is defined by the following formula: Preset shutter speed = SVR[15…0] x (1H cycle time) + SHR[15…0] x (1CLK cycle time) Note 1: The camera works with the shutter off position (maximum frame exposure time) when both SVR and SHR are set at “0”. Note 2: The camera works with the minimum shutter speed when SVR is set to 0 and this value is set between 1 and 306. Note 3: The value replaces by 779 automatically when the value set greater than 779.
24H: PSR[7..0] 25H: PSR[15…8]	[Start line of the variable partial scanning] Initial Data: PSR[15…0] = 0, Data Range: 0 to 493 Sets the start line number of the variable partial scanning area. Actual start line of the partial scanning = this value + 1 Note 1: The camera works with full scanning mode when the value of (PSR[ ] + PWR[ ]) is greater than 494. Note 2: The value replaces by 493 automatically when the value set greater than 493
26H: PWR[7…0] 27H: PWR[15…8]	[Effective line numbers in the variable partial scanning] Initial Data: PWR[15…0] = 494, Data Range: 0 to 494 Sets the number of the total effective lines (image height) in the variable partial scanning mode. Notes: 1. The value replaces by 494 automatically when the value set greater than 494. 2. The camera works with full scanning mode when the value of (PSR[ ] + PWR[ ]) is greater than 2058.

<table>
<tr><th>Command No.</th><th>Command Descriptions</th></tr>
<tr><td>28H:
DLY[7…0]
29H
DLY[15...8]</td><td>[Delay time for the trigger] Initial Data: DLY[7…0] = 0, Data Range: 0 to 65,535
Sets the delay time from the trigger input signal to the start of the exposure.

At 90 fps: Delay time (us) = 74 x 0.0271606 * DLY[7…0] = 2.0099 (us) * DLY[7…0],
At 60 fps: Delay time (us) = 74 x 0.0407408 * DLY[7…0] = 3.0148 (us) * DLY[7…0],
At 30 fps: Delay time (us) = 74 x 0.0814816 * DLY[7…0] = 6.0296 (us) * DLY[7…0],
where CLK = pixel clock.</td></tr>
<tr><td>30H
PGA[7…0]</td><td>[CDS gain] Initial Data: PGA[7…0] = 0, data range: 0 to 255
Sets the CDS gain (programmable analog gain).

CDS gain (dB) = ((PGA[7..0] + GOFS[7..0]) * 2 * 0.0351) + 6

*GOFS[7...0]: The gain offset (The value of the address 32H)</td></tr>
<tr><td>31H
DGB[7…0]</td><td>[Digital gain] Initial Data: The factory adjusted value, data Range: 0 to 255

Output level = (input level - CLAMP[7…0]) * (1 + DGB[7..0] / 128) + clamp level

*CLAMP[7...0]: clamp level (The value of the address 38H)</td></tr>
<tr><td>32H
GOFS[7…0]</td><td>[Gain offset] Initial Data: The factory adjusted value, data range: 0 to 255</td></tr>
<tr><td>38H:
CLAMP[7…0]</td><td>[Clamp level] Initial Data: CLAMP[7…0] = 9, Data Range: 0 to 255
Sets the clamp level value of the black level.

At 12-bit output: Clamp level = CLAMP[7…0] x 8 + 56
At 10 bit output: Clamp level = (CLAMP[7...0] x 8 + 56) / 4
At 8-bit output: Clamp level = (CLAMP[7...0] x 8 + 56) / 16</td></tr>
<tr><td>3EH: TP0[7…0]
3FH:TP0[9…8]</td><td>[Test pattern level] Initial data: 768 (300H), data range: 0 to 1023
Sets the output level of the test pattern 4: Raster (variable level) in 10-bit output format.</td></tr>
<tr><td>54H:
STRBDLY[7..0]
55H:
STRBDLY[15..8]
56H:
STRBDLY[23..16]</td><td>[Delay time (us) for the strobe signal]
Initial data: STRBDLY[23..0] = 0, data range: 0 to 2,000,000</td></tr>
<tr><td>58H:
STRBPOL[7..0]</td><td>[Strobe signal polarity] Initial data: IOSIGNAL_POL[7..0] = 00H,
Sets the strobe signal polarity.
D[7..0]
<table><tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr></table>
D7 to D1 No Function Always set as “0000000”
D0: Strobe signal polarity 0: Non-invert 1: Invert</td></tr>
</table>

<table>
<tr><th>Command No.</th><th>Command Descriptions</th></tr>
<tr><td>78H:
TESTP[7…0]</td><td>[Test pattern selection] Initial data: TESTP[7..0] = 00H
Sets the test pattern output from the camera.
D[7..0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7 to D5 No Function Always set as “000”
D4 to D0 Test pattern 00H: Video output 01H: Gray scale
02H: Horizontal ramp wave 03H: Uniform gray level (100% white)
04H: Uniform gray level (variable level) 05H: Color bar
06H: Vertical ramp wave Others: Black</td></tr>
<tr><td>79H:
EFFCT[7..0]</td><td>[Image effect selection] Initial data: EFFCT[7..0] = 00H
Sets the image effect.
D[7..0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7: Negative / Positive video selection 0: Positive image 1: Negative image
D6 No function Always set as “0”
D5 to D0: Image effect 00H: No effect (Original) 01H: 11bit gradation
02H: 10bit gradation 03H: 9bit gradation
04H: 8bit gradation 05H: 7bit gradation
06H: 6bit gradation 07H: 5bit gradation
08H: 4bit gradation 09H: 3bit gradation
0AH: 2bit gradation 0BH: 1bit gradation
0C to 3FH: No function
(Prohibited settings. Do not set these values)</td></tr>
<tr><td>80H:
E2P[7…0]</td><td>[EEPROM control] Initial data: E2P[7…0] = 0
Sets the image effect.

D[7..0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7 to D2: No function Always set as “000000”
D1: Register synchronous update with the EEPROM data 0: Prohibited 1: Accept
D0: Write control to the EEPROM 0: Prohibited 1: Accept

Note: This bit is cleared to “0” automatically by the internal processes after the execution of the command.</td></tr>
<tr><td>94H:
STRB[7..0]
95H:
STRB[15..8]
96H:
STRB[23..16]</td><td>[Active time (us) for the strobe signal] Initial data: STRB[23..0] =0, data range: 0 to 2,000,000
Sets active time for the strobe signal.</td></tr>
</table>

<table>
<tr><th>Command No.</th><th>Command Descriptions</th></tr>
<tr><td>A0H:
PDC0[7…0]</td><td>[Pixel defect correction mode] Initial data: PDC0[7..0] = 0
D[7..0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7: Write the correction index 0 → 1
*Writes the coordinates of the command, A2 to A5, to the index number specified by the command A1.
*This bit is cleared to “0” automatically after the execution of the command.
D6 Read the correction index 0 → 1
*Reads the coordinates of the index number specified by A1 and loads them to the command, A6 to A9.
*This bit is cleared to “0” automatically after the execution of the command.
D5: Save to the EEPROM 0 → 1
*Writes the coordinates of all 16 index numbers to the EEPROM.
*This bit is cleared to “0” automatically after the execution of the command.
D4 to D2 No function Always set as “000”
D1 Correction indices display 0: OFF 1: ON
D0 Pixel defect correction 0: OFF 1: ON</td></tr>
<tr><td>A1H:
PDC0[7…0]</td><td>[Pixel defect correction index number]Initial data: PDC1[7..0] = 0, data range: 0 to 15
D[7..0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7 to D4: No function Always set as “0000”
D3 to D0: Index number</td></tr>
<tr><td>A2H:
PDC_WX[7…0]
A3H
PDC_WX[15…8]</td><td>[PDC X coordinate (Write)]
Initial data: PDC_WX[15..0] =0, data range: 0 to the number of horizontal pixels of the effective area
Set the X coordinate of pixel defect.</td></tr>
<tr><td>A4H:
PDC_WY[7…0]
A5H
PDC_WY[15…8]</td><td>[PDC Y coordinate (Write)]
Initial data: PDC_WY[15..0] = 0, data rage: 0 to the number of vertical pixels of the effective area
Sets the Y coordinate of pixel defect.</td></tr>
<tr><td>A6H:
PDC_RX[7…0]
A7H
PDC_RX[15…8]</td><td>[PDC X coordinate (Read)]
Initial data: PDC_RX[15..0] = 0, data rage: 0 to the number of vertical pixels of the effective area
The X coordinate of pixel defect will be loaded when reading.</td></tr>
<tr><td>A8H:
PDC_RY[7…0]
A9H
PDC_RY[15…8]</td><td>[PDC Y coordinate (Read)]
Initial data: PDC_RY[15..0] = 0, data rage: 0 to the number of vertical pixels of the effective area
The Y coordinate of pixel defect will be loaded when reading.</td></tr>
<tr><td>C0H: [7…0]
C1H: [7…0]</td><td>[Lower limit of the electronic shutter] Initial data: 1; data range: 0 to 4,095
Sets the upper limit of the electronic shutter in horizontal lines when using AE (auto exposure).</td></tr>
<tr><td>C2H: [7…0]
C3H: [7…0]</td><td>[Upper limit of the electronic shutter] Initial data: 4,095; data range: 0 to 4,095
Sets the upper limit of the electronic shutter in horizontal lines when using AE (auto exposure).</td></tr>
</table>

<table>
<tr><th>Command No.</th><th>Command Descriptions</th></tr>
<tr><td>C5H: [7…0]</td><td>[Look-up table (Gamma)] Initial data: [7..0] = 00H
D[7..0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7 to D3: No function — Always set as “00000”
D2: Look-up table (RAM) — 0: OFF; 1: Load
D1: Look-up table upload — 0: RAM only; 1: RAM and ROM
D0: No function — Always set as “0”</td></tr>
<tr><td>F0H:[7…0]</td><td>[Signal selection for the I/O connector] Initial data: [7…0] = the value of 00H, data range: 0 to 15
Sets the signals of the I/O connector.
D[7..0]
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>

D7 to D4: No function — Always set as “0000”
D3~D0: The signals of the /IO connector selection
0H: Option 0; 1H: Option 1
2H: Option 2; 3H: Option 3
4H: Option 4; 5H: Option 5
6H: Option 6
7H to FH: No function
(Prohibited settings. Do not set these values)

Please refer to the table 3 I/O Connector Settings for the details.</td></tr>
</table>

Revision History

Rev	Date	Changes	Note
1.00	2012/06/20	● Initial Release	
1.01		● Updated Camera Output Timing Horizontal Timing Communication Protocol 20-21H SVR 78H Test pattern 79H Pasteurization Deleted F1H command due to test use only	

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